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AUTHOR Han, Lei; And Others
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ABSTRACT

This study investigated gender differences on the ACT English and mathematics scores by controlling both high school course taking patterns and high school subject matter course grades. A sample of 5100 ACT test takers (44% male) from the 1989-1990 academic year was selected for this study. Data were analyzed separately for juniors and seniors. Analyses of variance using the general linear model were employed to deal with disproportional cell frequencies. The gender differences favoring males on the mathematics scores were most pronounced for those having moderate math backgrounds, but differences favored junior females who had full math backgrounds. The findings were discussed in terms of the results and designs of previous studies of gender differences on admission test scores. (Contains 16 references and 7 tables.) (Author)

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Gender Differences in High School Grades and ACT Scores

Lei Han, T. Anne Cleary*, and Margaret M. Clifford

University of Iowa

Abstract

This study investigated gender differences on the ACT English and mathematics scores by controlling both high school course taking patterns and high school subject matter course grades. A sample of 5100 ACT test takers (44% males) from the 1989-1990 academic years was selected for the study. Date were analyzed separately for juniors and seniors. Analyses of variance using the general linear model were employed to deal with disproportional cell frequencies. The gender differences favoring males on the mathematics scores were most pronounced for those having moderate math backgrounds, but differences favored junior females who had having full math backgrounds. The findings were discussed in terms of the results and designs of previous studies of gender differences on admission test scores.

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* This paper is based on the first author's master thesis equivalency supervised by the late Professor T. Anne Cleary.

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Gender Differences in High School Grades and ACT scores

Objectives of the Study

Course grades and standardized test scores are traditionally used as measures of high school learning and achievement. Differential performance by males and females on standardized tests have been discussed extensively among educators (Wilder and Power, 1989). Previous research has identified several variables that relate to gender differences in academic performance, including, differences in career interests and achievement motivation (Farmer, 1987), and differences in course participation. Fewer females than males take advanced mathematics courses in high school, providing partial explanation for females' lower scores on mathematics test scores (Fennema,1977; Wise, 1985). Efforts have been made to control for students college major choice, career interest, and number and type of courses taken in high school to understand gender differences better. Results from these studies showed that gender differences tended to be smaller, but were not eliminated by controlling these factors (Gamache & Novick, 1983; Clark & Grand,1984; Doolittle & Cleary, 1987).

Research has also demonstrated a strong relationship between achievement test scores and the number of courses taken in high school, particularly in mathematics and science (Laing, Engen, & Maxey, 1987). This relationship remained substantial after covariance adjustments were made for student socioeconomic status and premeasured verbal and mathematics abilities (Jone, etc. 1986). Previous research also showed a relationship between achievement test scores and high school grade point average (GPA) and high school rank (Loyd, Forsyth, & Hoover, 1980; Noble & McNabb, 1989). Noble & McNabb (1989) used regression analysis to examine how much variance of ACT scores could be explained by number of courses taken in high school, course grades, and other background variables. They found that both number of courses taken and course grades were significant predictors of ACT scores. Regression models did not differ significantly

for males and females. However, there were no direct comparisons of males and females who took the same patterns of coursework and had the same course grades.

The present study was designed to control course completion patterns and course grades simultaneously to compare gender group performances on the ACT. The specific questions addressed were:

1) Are there gender differences in ACT scores when high school course completion patterns are controlled?

2) Are there gender differences in ACT scores when high school subject matter grades are controlled?

3) Are there gender differences in ACT scores when both high school course completion patterns and subject matter grades are controlled?

Because previous research showed that students who took the ACT as juniors differed in several ways from those who took the ACT as seniors (Noble & McNabb, 1989), these questions were addressed separately for high school juniors and seniors, using both ACT English and mathematics scores.

Method

Subjects

A sample of 5100 Illinois students (44% males) who had taken the Enhanced ACT during the 1989-1991 academic years was selected in a systematic way from ACT history files. Because of missing data, (e.g. some did not provide information on about their high school courses taken or courses grade), the final sample consisted of 4284 students (44% males) for the analysis of English scores and 3205 students (43% males) for the analysis of mathematics scores. About two-thirds of the subjects were juniors.

Instrument

The Enhanced ACT Assessment, the new version of the ACT Assessment, consists of four academic tests (English, mathematics, reading, and science reasoning), the self-reported High School Course/Grade Information (HSCGI), the ACT Interest Inventory,

and the Student Profile Section (SPS). The HSCGI of the Enhanced ACT Assessment elicits information on high school courses taken by students and grades they received in these courses. The maximum number of courses analyzed in this study was four for English and six for mathematics. The accuracy of this self-reported data was examined and found to be reliable for most academic purposes (Sawyer, Laing, and Houston, 1988).

Analyses

Analyses of the HSCGI indicated that 97% of the juniors had three English courses, and 91% of the seniors had four English courses. Students' mathematics course sequences revealed a variety of patterns. The following five groups were formed for this study:

Group 1: Algebra-I or Algebra-I and Geometry;

Group 2: Algebra-I, Geometry, and Algebra-II;

Group 3: Algebra-I, Geometry, Algebra-II, and Trigonometry;

Group 4: Algebra-I, Geometry, Algebra-II, Trigonometry, and other advanced math courses;

Group 5: Algebra-I, Geometry, Algebra-II, Trigonometry, Calculus and the other advanced math courses or not.

Separate grade point averages (GPA) were computed for these English and mathematics courses and ranged from 1.0 to 4.0. GPA cutoff scores of 2.5 and 3.5 were used to classify students into low, middle, and high GPA levels. The reason of choosing such cutoff scores was to keep the sample size in each category as large as possible. Gender was the primary factor of concern. The dependent measures were the Enhanced ACT English and mathematics scores. Two GPA* Gender (3*2) and two math Group*GPA*Gender (5*3*2) factorial analyses of variance were conducted for juniors and seniors separately. The SAS general linear model (GLM) was used to cope with the unbalanced design created by disproportional cell frequencies.

Results

Gender differences in English performance:

Descriptive statistics for ACT English scores by gender and GPA level are shown in Table 1. The ANOVA results (see Table 2) indicated that for both juniors and seniors, the English GPA with Gender interactions were not statistically significant. As predicted, the GPA main effects were significant ($p<0.00$) for both juniors and seniors. Follow-up tests showed that there were significant differences for adjacent GPA levels on the ACT English scores. The Gender main effects were not statistically significant for either juniors or seniors. The effect sizes for gender were -0.12 and -0.14 for juniors and seniors, respectively (see Table 1), which indicated that, on the average, females had slightly higher English scores than males. It should be noticed that the proportions of males and females distributed in three GPA levels differed significantly. More females than males were in the highest English GPA level, but the opposite was true in the lowest GPA level.

Gender differences on mathematics performance

Descriptive statistics for ACT mathematics scores by math Group are listed in Table 3. The ANOVA results for ACT mathematics scores are summarized in Table 4. It can be seen from Table 4 that none of the interactions involving Gender were statistically significant. As expected, both Group (number and pattern of math courses taken) and GPA main effects were significant ($p<0.001$). Follow-up tests indicated significant differences for adjacent group comparisons. Gender main effects were significant for both juniors and seniors ($p<0.001$), and the effect sizes (see Table 3) were 0.23 and 0.27 for juniors and seniors, respectively. This means that, on the average, males earned higher ACT mathematics scores than females by about one-fourth of a standard deviation.

It can be seen in Table 3 that the proportions for males and females in each math group are about the same. Differential course selection between males and females did not exist in this sample. Females consistently performed less well than males, except for juniors in group 5. Gender differences tended to be smaller for groups in which the least

amount of math was taken. The largest differences occurred between those males and females who took a moderate number of mathematics courses (effect sizes were about 0.30). Of additional interest was that the gender difference favored females for juniors who had taken all the advanced mathematics courses (Group 5). The effect size was -0.29. This finding has not been reported previously.

Descriptive statistics for males and females at three mathematics GPA levels are summarized in Table 5. All the effect sizes across the three GPA levels favor males and were greater than 0.20, and the largest difference occurred at the highest GPA level for seniors (effect size =0.48). This pattern suggested that females consistently performed less well than males even after matching on mathematics GPA level. The proportions of males and females distributed in three math GPA levels were about the same.

In summary, the major findings of this study were there were no significant gender differences in ACT English scores. There were significant gender differences in ACT mathematics scores. Males consistently performed better than females even by matching the same course-taking pattern and at the same subject matter grade level

Summary statistics for ACT scores and high school GPA in English and mathematics are listed in Table 6. It can be seen that gender differences favoring females were observed in high school English GPA, but they did not show up in the analysis of ACT English scores; gender differences did not exist in mathematics GPA, but showed up in the ACT mathematics scores. These patterns are the same for both juniors and seniors. The results of this study suggested that gender differences in ACT test scores and high school GPAs were inconsistent.

Discussion

This study used ANOVA to control both course-taking pattern and course grade to study gender differences. By using the general linear model to deal with the unbalanced design, the statistical test results differ from those that would have been obtained if the design had been balanced. Because of the power of the statistical tests achieved through

the use of large samples in this study, it is more meaningful to look at the actual effect sizes when judging how large gender differences are. That is the reason we list the effect sizes in the tables. The gender differences across different math course-taking groups revealed an important pattern even though it was not statistically significant. That is the magnitude of differences tended to be small for groups in which students had taken few or many math courses, but it tended to be large for those who had taken a moderate number of math courses. A gender difference favoring females was found among juniors who had completed all advanced math courses. Because the sample size was small in this group, caution should be used when interpreting this result. Further research should be done on this particular group to examine whether this result can be replicated.

The inconsistencies of gender differences on high school subject matter grades verse standardized achievement test scores can be related to the following factors:

1) Grading bias. Because of different expectations for males and females, teachers may have different criteria in assigning course grades for males and females. A final course grade may be derived from different components, such as completion of homework assignments, personal-social behaviors, and test scores. Females tend to do better than males on the first two aspects; as a result, they obtain higher course grades than males. This hypothesis also was proposed by Clark and Grand (1984). However, no research has been done on this issue at the high school level.

2) Performance motivation. Males and females may have differential motivation on classroom assessments versus college admissions tests like the ACT. Males may be less motivated than females to get high grades, even though both groups may equally highly motivated to doing well on the ACT.

3) Study motivation. Differential career interests between males and females may influence their study motivation. Some female students who take mathematics courses in high school may lack the self-efficacy to engage in traditionally male-dominated areas such as engineering and mathematics (Betz, 1990). Their efforts or time spent in those courses

may not be as much as those whose career plans are mathematics oriented. To test this hypothesis, the most frequently chosen college majors for the juniors in three math groups (1, 3, and 5) were tracked, as listed in Table 7. Females in math group 5 most frequently chose business, health, and engineering as college majors. This is a highly selected group of females, and their math scores are competitive with their male counterparts. Because the sample size in this group is very small (2.6% of the junior sample), caution is needed when generalizing about this finding.

The results of this study suggest that further research needs to be done on possible grading bias in high school level. The pattern of gender differences across different mathematics training levels and its educational implications also deserve further study. We should encourage and facilitate females to complete advanced mathematics courses in high school and improve their self-efficacy in career pursuits of sciences and engineering. Developing young women's intelligence will benefit not only women in general, but will benefit all of society.

Table 1

Descriptive Statistics for ACT English Scores at Three GPA Levels

		Junior				Senior			
		Mean	SD	N	P(%)*	Mean	SD	N	P(%)
GPA>3.5	Male	24.71	4.71	273	23	21.32	5.30	91	13
	Female	24.47	4.57	512	34	22.47	4.91	179	20
	ES*	(0.05)				(-0.24)			
2.5<GPA<3.5	Male	21.29	4.44	568	47	19.32	4.48	271	39
	Female	21.19	4.54	723	48	19.35	4.74	394	45
	ES	(0.02)				(0.00)			
GPA<2.5	Male	18.16	4.32	354	30	16.86	4.23	331	48
	Female	18.17	4.14	278	18	16.81	4.07	310	35
	ES	(0.00)				(0.01)			
Total	Male	21.15	5.05	1195	44	18.41	4.75	693	44
	Female	21.74	5.01	1513	56	19.09	4.99	883	56
	ES	(-0.12)				(-0.14)			

*ES (effect size)= (male mean-female mean)/total sample SD
Negative values indicate females have higher scores
*P(%) = number of males or females in that category/ total number of males or females

Table 2

ANOVA for the ACT English Scores

	Overall F test					
	Junior			Senior		
	df	F	p	df	F	p
GPA	2	343.93	0.00	2	121.00	0.00
Gender	1	0.38	0.54	1	2.17	0.14
GPA*Gender	2	0.13	0.88	2	1.68	0.19
Error	2702			1570		

	Follow-up test	
GPA level comparison	Junior	Senior
high-moderate	*	*
moderate-low	*	*

* Statistically significant at 0.05 level.

Table 3

Descriptive Statistics for the ACT Mathematics Scores by Group by Gender

		Junior				Senior			
		Mean	SD	N	P(%)*	Mean	SD	N	P(%)
Group I	Male	17.13	2.55	155	17	15.62	2.41	121	26
	Female	16.26	2.40	224	19	14.97	2.07	178	28
	ES*	(0.17)				(0.15)			
Group II	Male	21.68	4.01	446	49	18.23	2.98	142	30
	Female	20.82	3.88	572	48	17.46	3.03	196	32
	ES	(0.17)				(0.18)			
Group III	Male	24.73	4.28	196	21	20.78	3.96	101	22
	Female	23.36	4.37	255	21	19.48	3.26	135	22
	ES	(0.28)				(0.30)			
Group IV	Male	27.44	3.73	85	9	23.31	3.89	62	13
	Female	25.85	4.11	129	10	21.49	3.44	80	13
	ES	(0.32)				(0.42)			
Group V	Male	29.53	3.89	34	4	25.25	4.40	43	9
	Female	30.95	4.05	20	2	24.64	4.43	33	5
	ES	(-0.29)				(0.14)			
Total	Male	22.39	5.03	916	43	19.42	4.57	469	43
	Female	21.22	4.89	1200	57	18.09	4.06	620	57
		(0.23)				(0.27)			

*ES (effect size)= (male mean-female mean)/total sample SD
Negative values indicate females have higher scores
*P(%) = number of males or females in that category/ total number of males or females

Table 4

ANOVA for the ACT Mathematics Scores

	Overall F test					
	Junior			Senior		
	df	F	p	df	F	p
Group	4	168.29	0.00	4	117.37	0.00
GPA	2	3.30	0.00	2	38.27	0.00
Gender	1	15.23	0.00	1	16.03	0.00
Group*GPA	8	2.91	0.00	8	3.35	0.00
Group*Gender	4	1.70	0.14	4	2.21	0.06
GPA*Gender	2	2.11	0.12	2	0.21	0.81
Group*GPA*Gender	8	0.96	0.46	8	0.27	0.98
Error	2087			1059		

	Follow-up test	
GPA level comparison	Junior	Senior
high-moderate	*	*
moderate-low	*	*
Group level comparison		
group1- group2	*	*
group2- group3	*	*
group3- group4	*	*
group4- group5	*	*

* Statistically significant at 0.05 level.

Table 5

Descriptive Statistics for ACT Mathematics Scores at Three GPA Levels

		Junior				Senior			
		Mean	SD	N	P(%)*	Mean	SD	N	P(%)
GPA>3.5	Male	26.52	4.44	233	25	23.68	4.61	76	16
	Female	24.84	4.64	350	29	21.59	4.4 4	107	17
	ES*	(0.34)				(0.48)			
2.5<GPA<3.5	Male	22.77	4.21	337	38	20.63	4.11	139	30
	Female	21.73	3.95	428	36	19.15	3.56	186	30
	ES	(0.21)				(0.34)			
GPA<2.5	Male	19.22	3.84	246	38	17.48	3.62	254	54
	Female	17.69	3.27	422	35	16.35	3.03	327	53
	ES	(0.31)				(0.26)			
Total	Male	22.39	5.03	916	43	19.42	4.57	469	43
	Female	21.22	4.89	1200	57	18.09	4.06	620	57
	ES	(0.23)				(0.31)			

*ES (effect size)= (male mean-female mean)/total sample SD
Negative values indicate females have higher scores
*P(%) = number of males or females in that category/ total number of males or females

Table 6

Descriptive Statistics for the ACT Scores and High School GPA by Grade and Gender

		ACT				H S GPA			
		English		Mathematics		English		Mathematics	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
Junior	Male	21.15	5.05	22.39	5.03	2.90	0.70	2.81	0.83
	Female	21.74	5.01	21.22	4.89	3.14	0.64	2.89	0.83
	ES*	(-.012)		(0.23) **		(-0.35) **		-0.10	
	Total	21.24	5.03	21.72	4.89				
Senior	Male	18.41	4.75	19.42	4.57	2.64	0.71	2.51	0.85
	Female	19.09	4.99	18.09	4.00	2.83	0.71	2.55	0.86
	ES*	(-0.14)		(0.27) **		(-0.27) **		-0.05	
	Total	18.79	4.89	18.66	4.31				

* ES (effect size) = (male mean - female mean) / total sample SD.
Negative values indicate females have higher scores

**Statistically significant at 0.01 level.

Table 7

Three Most Frequently Chosen College Majors for Three Groups (Juniors)

Group 1		Group 3		Group 5	
Male	Female	Male	Female	Male	Female
Business	Business	Business	Business	Engineering	Business
Communication	Health	Engineering	Health	Health	Health
Psychology	Education	Medicine	Medicine	Law	Engineering

REFERENCES

Betz, N. E. (1990). What stops women and minorities from choosing and completing majors in science and engineering? Paper presented at Science and Public Policy Seminar. Washington, DC: Federation of Behavioral, Psychological and Cognitive Sciences.

Clark, M. J., & Grand, J. (1984). Sex differences in the academic performance of Scholastic Aptitude Test takers. (College Board Report No.84-8). New York: College Entrance Examination Board.

Cleary, T. A. (1990). Gender differences in aptitude and achievement scores. Paper present at annual meeting of the ACT Corporation. Iowa city, IA.

Doolittle, A. E. & Cleary, T. A. (1987). Gender-based differential item performance in mathematics achievement items. Journal of Educational Measurement, 24, 157-66.

Doolittle, A. E. (1987). Gender differences in performance on mathematics achievement items. (ACT Research Report Series, No. 87-16). Iowa city, IA: The American College Testing Program.

Farmer, H. (1987). A multivariate model for explaining gender differences in career and achievement motivation. Educational Researcher, 16, 5-9.

Fennema, E. (1977). Influences of selected cognitive, affective, and educational variables on sex-related differences in mathematics learning and studying. Women and Mathematics: Research perspectives for change. Washington D.C.: The National Institute of Education.

Ganache, L. M. & Novick, M. R. (1983). Choice of variables and gender differentiated prediction within selected academic programs. Journal of Educational Measurement, 22, 53-70.

Jones, L. V., Davenport, E. C., Bryson, A., Bekhuis, T., & Zwick, R. (1986). Mathematics and science test scores as related to courses taken in high school and other factors. Journal of Educational measurement, 24, 197-208.

Laing , J., Engen, E. H., & Maxey, J. (1987). Relationship between ACT test scores and high school courses. (ACT Research Report Series. No. 87-3). Iowa city, IA.

Loyd, B. H., Forsyth, R., & Hoover, H. D. (1981). Relationship of elementary and secondary school achievement test scores to later academic success. Educational and Psychological Measurement, 41, 1117-1125.

Noble, J., & McNabb, T. (1989). Differential coursework and grades in high school: Implications for performance on the ACT Assessment.(ACT Research Report Series, No. 89-5). Iowa city, IA: The American College Testing Program.

Rosser P.(1987). Sex bias in college admissions tests: Why women lose out. National Center for Fair and Open Testing.

Sadker, M., & Sadker, D. (1986). Sexism in the classroom: from grade school to graduate school. Phi Beta Kappan, 67, 512-15.

Wilder, G. Z., & Powell, K. (1989). Sex differences in test performance: a survey of the literature. (College Board Report. No.89-3). New York: College Entrances Examination Board.

Wise, L. (1985). Project TALENT: Mathematics course participation in the 1060s and its career consequences. Women and Mathematics: Balancing the equation.